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(54) WORKING ALUMINIUM

(71) We, THE BRITISH PETROLEUM COMPANY LIMITED, of Britannic House, Moor Lane, London, E.C.2, a British Company, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to a liquid useful for working aluminium e.g. by grinding, cutting, drilling or shaping.

Aluminium is a difficult metal to lubricate whilst carrying out working operations; hitherto petroleum fractions such as kerosine containing particular additives have been used for this purpose. We have now discovered a class of liquids which alone or in admixture with other liquids have improved aluminium working properties.

The invention provides a method of working aluminium in which the liquid used as a lubricant comprises a liquid polycyclic hydrocarbon in which at least one ring is an aromatic ring and which contains a non-aromatic hydrocarbyl group.

The liquid polycyclic hydrocarbon can consist of an aromatic ring joined to a carbocyclic ring or it can consist of an alkyl substituted polycyclic aromatic compound e.g. an alkylnaphthalene. The preferred compounds are tetralin, and α-alkyl naphthalenes preferably in which the alkyl group contains 1—10 carbon atoms e.g. α-methyl, α-ethyl or α-isopropyl naphthalene.

When it is desired to produce an aluminium powder, aluminium can be ground in a liquid polycyclic hydrocarbon in which at least one cyclic ring is an aromatic ring and which contains a non-aromatic hydrocarbyl group, or it can be ground in an organic grinding/liquid polycyclic hydrocarbon mixture.

The organic grinding liquid/liquid polycyclic hydrocarbon contains preferably 5—100%, more preferably 10—100% of the liquid polycyclic hydrocarbon.

Suitable mills for grinding the aluminium are vibratory mills especially vibratory ball mills. The vibratory mill can be magnetically, hydraulically or pneumatically driven. Preferably the grinding chamber is entirely filled with liquid.

For liquids to be used in other working operations on aluminium the lubricating base liquid can be any of the lubricating base liquids used in the working of aluminium e.g. kerosine or lubricating base oils.

Preferably the lubricating base liquid/liquid polycyclic hydrocarbon mixture contains 1—99% by weight of the liquid polycyclic hydrocarbon, more preferably 5—99% wt.

Working operations on aluminium which can be lubricated by the lubricating composition include grinding cutting, shaping and drilling.

The aluminium powders produced by grinding, aluminium using compositions of the present invention can be used as pigments, fuels and for other purposes in which highly surface active aluminium powders are required.

It is a feature of the present invention that it enables aluminium to be ground to produce a highly surface active aluminium powder. It has been found that in grinding aluminium using a grinding liquid the higher the surface energy of the aluminium powder which is produced, the better the lubricating effectiveness of the grinding liquid in aluminium working operations.

The surface energy of aluminium powders can be measured using the Flow Microcalorimeter as described in Chemistry and Industry 20th March, 1965 pages 482—489 with n-butanol as the adsorbed liquid.

The invention will now be described with reference to the following Examples.

Example 1.

Aluminium was ground in a "Megapact" (Registered Trade Mark) vibratory ball mill manufactured by Pilamec Ltd.

In this mill the grinding chambers are steel cylinders of 1½ inches internal diameter by 15 inches long and are nearly filled with ¼ inch diameter hardened steel balls. The mill is fitted with a ¼ horsepower electric motor and the oscillation can be adjusted from 1 to 4 mm. In operation, each cylinder was

filled completely with a liquid. The ends were then sealed with metal caps fitted with rubber washers and grinding carried out at an oscillation of 4 mm and a frequency of 3000 vibrations per minute. After grinding for 4 hours the balls were sieved from the slurry of metal powder and liquid and the treated metal powder recovered by filtration, washing and drying.

The surface energies of the metal powders were measured by measuring the heat of adsorption of n-butanol from *n*-heptane using the Flow Micro Calorimeter as described in Chemistry and Industry of 20th March, 1965 pages 482—489.

The results are shown in the Table, in which other grinding liquids are included for comparison.

TABLE

Grinding Liquid	Surface Energy Cal per Gram×10^{-3}	Surface Area (BET N_2 Adsorption) m^2/g
1. n-heptane	No powder produced *	0.1
2. Toluene	(coarse powder) 8	0.3
3. decalin	15	0.7
4. tetralin	53	2.6
5. α-methyl naphthalene	78	3.7
6. Lubricating oil	27**	1.3

* With n-heptane only lumps of aluminium were produced.

** The lubricating base oil was a solvent refined base oil of viscosity 160 seconds (Redwood 1) at 140°F and Viscosity Index of 95.

Thus it can be seen that the liquids of the invention, tetralin and α-methyl naphthalene, give rise to finer powder than the other liquid hydrocarbons, which is beneficial in grinding and metal working operations. The fine powders 4 and 5 are stable in room temperature, but oxidize rapidly when heated to temperatures exceeding 200° C, with considerable evolution of heat.

Example 2.

Materials Used in Example

(a) α-methyl naphthalene—Laboratory Reagent Grade ex BDH

(b) n-Tetradecane—ex Sunbury Hydrocarbon Bank sample No. 20

(c) Royal Standard kerosine—ex oil stocks

Viscosity data on the above fluids are given in Table 2.

Test Methods

1. *Pin-on-Disc Machine Tests*

Pins, ¼ inch in diameter with conical tips of 120° included angle were machined from commercially pure aluminium of hardness 27 HV. The pins were run against hardened EN 31 discs, of hardness 850 HV, under a load of 1 kg at a sliding speed of 3 cm/s. The test duration was 330 minutes. The loss in weight of the pin was measured at the termination of each test. The results quoted are the mean of at least two determinations. In general the reproducibility was good, being better than ± 5 per cent in most cases.

2. *Drilling Torque Tests*

The test consists essentially of drilling five holes in a pure aluminium bar in the presence of the test fluid and measuring the peak torque recorded on the drill. A 10 mm diameter drill was used at a feed rate of 0.35 m/rev at .530 rev/m. The aluminium test bars were 25 mm thick.

3. *Staining Tests*

Three drops of test fluid were placed on squares of "bright" aluminium sheet which were then folded and placed in an oven for 30 minutes. On removal, the aluminium squares were unfolded and visually examined for signs of staining.

Results

1. *Pin-On-Disc Machine Test Results*

The results of the pin-on-disc machine wear tests are listed in Table 3. A direct comparison between the aromatic and paraffinic fluids of similar viscosities reveals that α-methylnaphthalene gave lower friction and wear values than n-tetradecane. α-Methylnaphthalene also showed improved anti-wear properties when compared to kerosine, a commonly used aluminium rolling fluid.

2. *Drilling Torque Tests*

The results of the drilling torque tests are

listed in Table 4 α-methylnaphthalene again showed improved (lower) torque values than both n-tetradecane and kerosine.

3. *Staining Tests*

The fluids were submitted to staining tests at 250° C and 350° C. All three fluids gave a clear pass.

TABLE 2

Viscosity Data

Fluid	Viscosity cSt		
	100°F	140°F	210°F
Kerosine	1.800	–	0.8100
α-Methyl Naphthalene	2.222	1.506	0.9210
n-Tetradecane	2.197	1.566	0.9937

TABLE 3

Pin-On-Disc Machine Test Results

Fluid	Weight Loss mg	Friction Coefficient
α-Methyl Naphthalene	2.9	0.20
n-Tetradecane	3.6	0.25
Kerosine	3.8	0.21

TABLE 4

Drilling Torque Test Results

Fluid	Torque Nm
α-Methyl Naphthalene	12.0
Kerosine	>15.0
n-Tetradecane	>15.0

WHAT WE CLAIM IS:—

1. A method of working aluminium in which the liquid used as lubricant comprises a liquid polycyclic hydrocarbon in which at least one ring is an aromatic ring and which contains a non-aromatic hydrocarbyl group.

2. A method as claimed in claim 1 in which the lubricant contains 1—99% by weight of the liquid polycyclic compound, and 99.1% of a lubricating base liquid.

3. A method as claimed in claim 2 in which the lubricant contains 5—99% by weight of the liquid polycyclic compound, and 95—1% of a lubricating base liquid.

4. method as claimed in any one of claims 1—3 in which the lubricating base liquid is a lubricating base oil or kerosine.

5. A method as claimed in any one of claims 1—4 in which the liquid polycyclic hydrocarbon is tetralin or an α-alkyl naphthalene.

6. A method as claimed in claim 5 in which the α-alkyl naphthalene is α-methyl, α-ethyl or α-isopropyl naphthalene.

7. A method as claimed in claim 1 as hereinbefore described with reference to the Examples.

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